



# Bicontinuous Composite Nano-Mm Sized Particles, 1D, 2D And 3D Structures For Impact Resistance And Energy Dissipation

Tech ID: 32625 / UC Case 2020-201-0

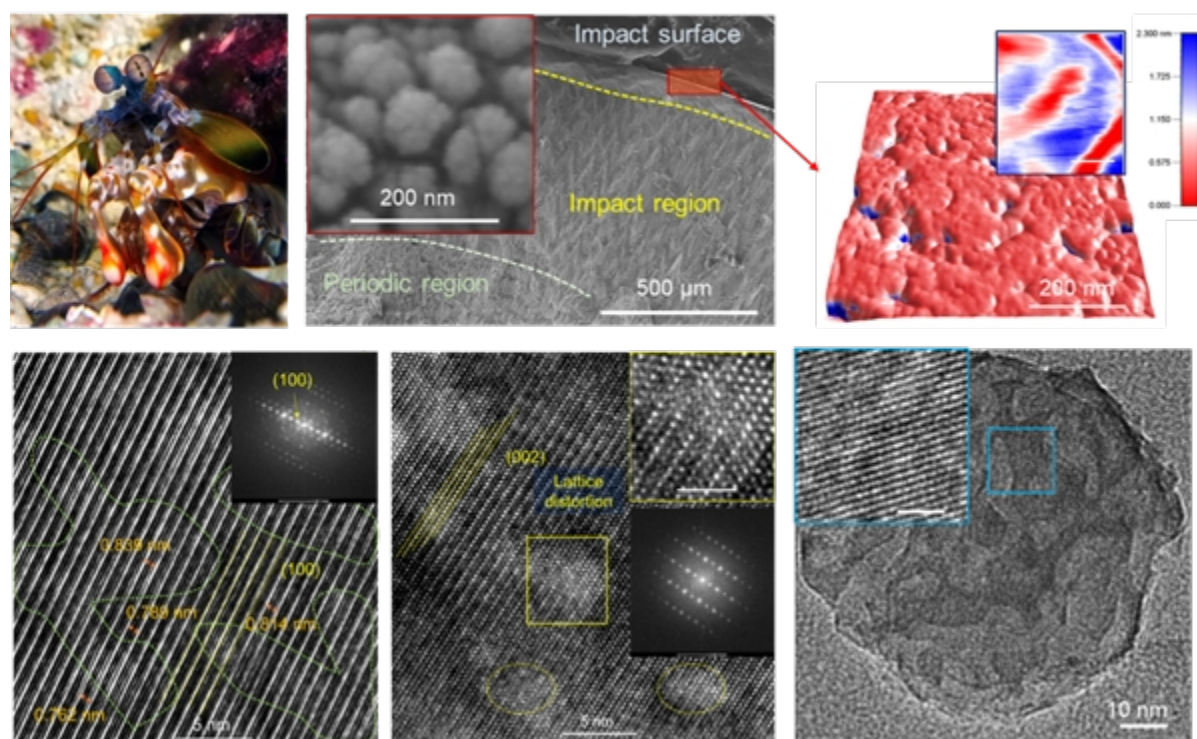
## FULL DESCRIPTION

### Background

Materials with unique architectures that can absorb significant amounts of energy from high strain rate impacts are needed in many applications from aerospace or automotive applications to sports or personal protective gear. Ballistic and other high strain rate impacts often present detrimental damage to multiple structures. Penetration or shattering of the underlying structure in these impacts can be catastrophic. Coatings applied to add an extra layer of protection do not protect well against high impact forces. Solutions that include inorganic particle coatings offer some energy absorption. However, in the case of high strain rate impacts, more damping and energy absorption are needed.

### Current Invention

Prof. David Kisailus and his team conducted studies of the outermost impact surface from the club of the mantis shrimp, which demonstrates incredible resistance to failure upon impacts greater than 300N of force at accelerations of more than  $100,000 \text{ m/s}^2$ . This inspiration has led to the development of a material and architectural design that absorbs significant amounts of energy. The design aspects include a particle with a bi-continuous network of stiff material inter-dispersed with a compliant matrix. This designed particle, upon high strain rate impact, will undergo deformation, yet maintain high stiffness.



Nanoparticles on the impact surface of the mantis shrimp dactyl club (Upper images). Lower left and middle high resolution micrograph showing protein and chitin organic phases interpenetrated with a hydroxyapatite network. Lower right showing inorganic network after high temperature treatment, indicating intact and porous framework of the hydroxyapatite phase.

## CONTACT

Venkata S. Krishnamurty  
[venkata.krishnamurty@ucr.edu](mailto:venkata.krishnamurty@ucr.edu)  
 tel: .

## OTHER INFORMATION

### KEYWORDS

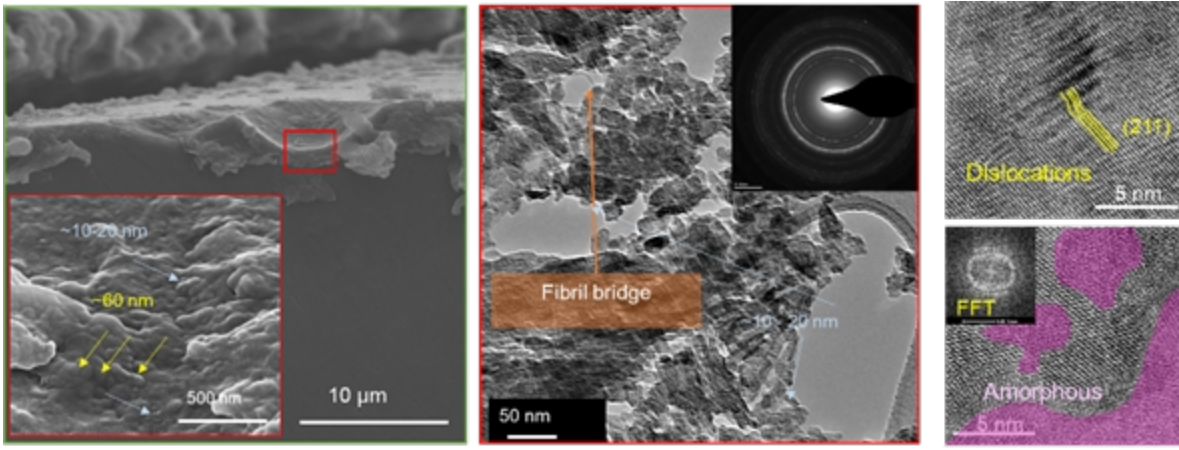
Composites, Nanoparticles, High Strain Rate, Impact Resistance, Energy Damping

### CATEGORIZED AS

- ▶ **Engineering**
  - ▶ Engineering
- ▶ **Materials & Chemicals**
  - ▶ Ceramics
  - ▶ Composites
  - ▶ Nanomaterials
  - ▶ Thin Films
- ▶ **Nanotechnology**
  - ▶ Materials
- ▶ **Security and Defense**
  - ▶ Other
- ▶ **Transportation**
  - ▶ Aerospace
  - ▶ Automotive

### RELATED CASES

2020-201-0



Energy dissipation mechanisms of the bicontinuous particles. Left and middle micrographs show particle breakage and fiber bridging after high strain rate impacts. Right high resolution micrographs show dislocations and amorphization induced by impacts.

## ADVANTAGES

- ▶ More impact resistance, energy dissipation and damping.
- ▶ Impact penetration depth is reduced by at least 50% with an ultra-thin layer of coating (~70m m).
- ▶ Multiscale energy dissipation mechanisms that help to mitigate catastrophic failure.
- ▶ Materials can be used interchangeably and as needed for the application.

## SUGGESTED USES

- ▶ Structural materials for aerospace and automotive composites.
- ▶ Sports or personal protective gear.
- ▶ Military armor
- ▶ Building panels that absorb impact

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20230288173	09/14/2023	2020-201
Patent Cooperation Treaty	Reference for National Filings	2022/026215	02/03/2022	2020-201

Additional Patent Pending

**University of California, Riverside**  
**Office of Technology Commercialization**  
 200 University Office Building,  
 Riverside, CA 92521  
[otc@ucr.edu](mailto:otc@ucr.edu)  
[research.ucr.edu/](http://research.ucr.edu/)